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ORIGINS OF SOVIET ROTORCRAFT

1. "The usual histories of rotary wing aircraft have practically ignored the Soviet work in this field. Yet, under Imperial and Soviet rule the Russians have participated in the development of rotorcraft. This account covers helicopters, autogiros and convertiplanes.

HELICOPTERS

2. "As with many other nations, Soviet interest in rotary wing aircraft dates back to the 18th Century. In those days most aerial experiments had but one goal--man's flight in a heavier than air craft. It was know as flight by 'mechanical means' to distinguish it from balloon flight. Aeronautics was coming into its own as a science known as 'pneumatics'. The word helicopter was still unknown. Clocksprings and whalebones were considered good sources of power for experiments. Late in the Century the steam engine came into being. It took 200 pounds to deliver one horsepower. Most of the flying machines never left the minds of their creators. When they did, they were often advised by their more sensible brethren to attach one or two balloons to them.

3. "In this setting the helicopter was introduced to Russia. The Soviet scientist, Mikhail V Lomonosov was first to undertake investigations on lifting screws. He was born in the year 1711 into a family of fishermen living in the coastal village of Denisova, near Archangel. In his youth, he went to sea with his father. Subsequently he entered the Slavonic-Greek-Latin Academy in Moscow, spending five years there.

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4. "In his late 20's he had the opportunity to enter the Russian Academy of Sciences. As one of its superior students, he was sent abroad to finish his education. Abroad, Lomonosov's fields of study were chemistry, metallurgy, mining, and mathematics. In 1745 he returned to Russia and was made professor at the Academy. There were no Soviet scientists and foreigners were invited to establish schools of higher learning and research. Those who went to Russia included such men as Bernoulli and Euler.

5. "On being named professor, Lomonosov became the first Soviet scientist to join the Academy. Thus, he is considered the father of Soviet science. Lomonosov did much to establish scientific investigating in his land. In his investigations, he delved into the fields of physics, chemistry, astronomy, geology and geography and at the meeting of the Academy in 1754 Lomonosov presented details of a device for lifting thermometers and other instruments into the air. He submitted a drawing of the apparatus for the consideration of the members. [redacted] In July of that year, the following appeared in the proceedings:

25X1

> 'The honorable Advisor Lomonosov demonstrated his invention called AERODYNAMIC to be used for the purpose of depressing the air by means of wings rotated horizontally in the opposite directions by the agency of a spring of the type used in clocks in order to lift the machine into the upper layers of the air.'

6. "The apparatus was suspended from a string and when the spring was wound, the device rose in the air. It is on this event that present-day Russia claims priority in the field of helicopters. The following is a news dispatch released in 1949:

> 'Helicopters today joined the Russian list of claimed "firsts". The Moscow Radio carried a broadcast on a new book on aviation which says the world's first helicopter was constructed in the middle of the 18th Century by a Russian.'

7. "In [redacted], the Frenchmen Launoy and Bienvenue presented to the Academy of Sciences in Paris their helicopter model. Bird feathers stuck in a cork were used for rotors. This device has been considered the first successful helicopter model.

8. "For over a century, the work of Lomonosov was the only rotorcraft activity to come out of Russia, until 1869 when the inventor, A N Ladygin, presented his idea for a helicopter project to the Central Engineering Agency. He called his apparatus 'Electroflier'. The fuselage resembled a long cylinder with a cone at one end and a hemisphere at the other [redacted] The hemisphere carried a propeller which was movable laterally for propulsion and control. The machine was supported by a lifting rotor. To power the craft, he proposed an elementary electric motor delivering 300 hp driving the screws by means of a geared transmission. The Electroflier weighed 500 poods 18,000 lbs/. Energy for the motors was to come from storage batteries, which he failed to describe.

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9. "After consideration of Ladygin's project, one of the members of the Agency commented:

> 'Attempts to control an aerostat by means of propellers, sails, and wings, in the manner of windmills have been made repeatedly and have led to no useful results for this purpose.' He concluded that the proposal was 'entirely inapplicable in practice.'

10. "In 1870, Ladygin left Russia to further his objective. He worked on his proposal for many years. A few months after the start of World War I in 1914, he petititoned the Soviet government for a five thousand ruble subsidy to enable him to produce a machine. By this time, his original proposal had been transformed into an ornithopter capable of carrying one person. The proposal included four paddle wheels. Each paddle wheel was driven by a separate motor. The motors were energized by means of generators driven by a 20 hp engine. The craft had no rudders or elevators. Control was obtained by variation in the power distribution to the paddles. A stabilizing feature consisted of a mercury circuit which automatically varied the current to the motors if the craft was disturbed by a gust of wind.

11. "Ladygin found a supporter in Professor N L Kirpichev. He concluded: ' . . . there is no logical basis for assurance that his apparatus will not be capable of flying.' However on 12 Nov 14 an Army Technical Board, ever hopeful for a new weapon and not anxious to stick their necks out, reached the following conclusions:

'1. If successfully realized, a flying apparatus of the type proposed by the electrical engineer, Ladygin, could be of certain use to the cause of military aviation.
'2. Mr Ladygin's theoretical considerations and general calculations relating to his apparatus contain no inconsistencies or errors.'

The Army failed to provide funds and the course of the War prevented him from advancing his project, and shortly prior to the Russian Revolution he emigrated to the US, where he died in 1923.

12. "In 1870, M A Rykachev, a member of the Academy of Sciences and Director of the Central Physical Laboratory, conducted experiments on air screws to determine their efficiency 25X1 [redacted] and in 1888 the scientist, E S Fedorov, published a paper in the Proceedings of the Russian Technological Society. It presented a mathematical analysis of the possibilities of using air screws in flying machines.

13. "An aerial velocipede was proposed in 1897 by I Bykov [redacted]. The craft was a monocycle supported and propelled by means of a helical screw. Power was to be 25X1 obtained by pedalling the cycle. His proposal was presented to the Aviation Division of the Electrotechnical Committee, but was rejected.

14. "In September 1899, Nikita Mironovich Mitreikin, an artisan from the Moscow district, made public his design for an 'Aviation Bicycle'. The device consisted of two screws driven by the operator's feet. The inventor claimed he succeeded in lifting the machine one arshin /28 inches/ and flying a distance of about 5 sazhens /35 feet/. He offered his invention to the Ministry of War and pointed out that the apparatus 'can be of great use in military action, as it will be possible to remove wounded quickly, without shaking or rocking.'

15. "The new century introduced a number of rotary wing developments in Russia that were comparable in scope to those undertaken in other countries. In the general field of aeronautical engineering, Russia was progressive. Its efforts in aerodynamic research and unusual configurations were equal, if not superior, to the other European nations. However, in aircraft production, their machines and engines were copies of French, UK or US designs. There were a few outstanding Soviet designers, the most noted being Igor Sikorsky.

16. "In the early years of the 20th Century, the leading aeronautical engineer was Nikolai Zhukovskii. He came to be known as the 'Father of Soviet Aviation' but he was also claimed by Poland under the name of Joukowski. He is known by the latter name in the US, especially for his work on the analytical approach to developing airfoil sections. In 1889, Zhukovskii set up in Russia the first aerodynamic laboratory as part of Moscow University. In 1902, he added a wind tunnel to the laboratory.

17. "On 22 Jan 04, he released a communication 'On the Useful Load Lifted by a Helicopter'. He analyzed the main attempts to solve the problem of twin and multi-rotor helicopters. Zhukovskii wrote, 'On the basis of all that has gone before, it must be concluded that, given the present proportionate weight of the engine, a twin-propeller helicopter cannot lift into the air more than a definite useful load; as concerns multi-propeller helicopters, it is clear that with an increasing number of propellers they can lift any load. Moreover, multi-propeller helicopters designed for the same proportionate engine weight and the same useful load give lighter weight aircraft with less powerful engines than do twin-propeller helicopters.'

18. "In 1909, Zhukovskii gave a series of lectures on the 'Theoretical Elements of Aviation' at the Moscow Technical Institute. In 1914, a special course in aeronautics was organized. Some of his students became leaders in the field of rotary wing aircraft. Three of these were G K Sabinin, V P Wetchinkin, and B N Yuriev. Little is known of the helicopter work of Sabinin. Wetchinkin, in 1913, proposed a coefficient for evaluation of a rotor in hovering. In the early years, several engineers proposed coefficients, all involving thrust, power, and rotor diameter.

19. "In 1903, Renard in France was first proposing the 'qualite': $\frac{T^3}{HP^2 \times D^2}$ whereas Wetchinkin called his coefficient 'Otdatcha' and it was expressed by $\frac{T^{3/2}}{HP \times D}$. The concept is recognized in the US as the 'Figure of Merit'.

20. "Of the three early students only Boris N Yuriev came to be well-known. His association with helicopter development has been long, and transcended the Czarist and Soviet regimes. Today he is looked upon as the patriarch of Soviet helicopter engineering

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21. "Yuriev's helicopter activities began in 1909. In that year he proposed a coaxial rotor helicopter design. In the central part of the fuselage was located a 70 hp Gnome rotary engine which drove two two-bladed rotors of different sizes. The upper rotor was 29.5 feet in diameter and the lower one 9.85 feet. The machine incorporated a variable pitch 'steering propeller' for directional control. Wheels were provided for a running take-off. There were provisions for a parachute in case the engine failed. The weight of the machine was 694 pounds. Late in 1909, a second version was designed. Yuriev estimated 50 hp was required for take-off. The unavailability, locally, of power plants of this size precluded the possibility of building a machine.

22. "A 25-30 hp Anzani engine was available at the Moscow Aviation Club and he designed a modern looking helicopter around this power plant. [redacted] is a drawing of the

25X1 configuration. It consisted of a single two-blade lifting rotor and a tail rotor. The power plant was installed with its shaft vertical and slightly forward of the main rotor shaft. The drawing shows a power plant much larger than the one contemplated for use. The tail rotor was powered by means of a belt-drive system.

23. "In 1910, Yuriev applied for a patent on his device. A glorification of Soviet helicopter accomplishments in 'Ogonek' magazine, written by Yuriev, cites a Patent Certificate No 45212, granted him in 1910. Soviet patents of that era had lower numbers, less than 20 thousand. Evidently, he cites a patent application number. A check at the New York Public Library's patents from Russia indicates that the patent was never granted. What is more significant, however, is the fact that Yuriev appears to

25X1 be the first to develop the modern configuration of a tail rotor helicopter [redacted]

24. "In 1910, Emile Berliner in the US proposed a 'Gyrocopter' which consisted of a single lifting rotor with an antitorque tail rotor. Thrust was varied in the tail rotor by varying its diameter. He soon abandoned this for the coaxial configuration. As a result of his studies, Yuriev presented in 1911 a paper 'The Maximum Useful Load Lifted by Airplane and Helicopter with Engine of Given Power'.

25. "With the support of the Ledentsov Society, Yuriev constructed a prototype in 1912

25X1 designed around the Anzani engine. [redacted] The rotor diameter was 26.2 feet. He had devised a pitch change mechanism, but in order to save weight it was not incorporated in the prototype.

26. "It appears Yuriev understood the principle of autorotation applicable to helicopters for power-off descent. He writes, 'The student, Sorokovmovskii, proved that the blades of a large rotor revolving in air, with the motor idle, serve as a fully reliable parachute and can even be used to land at an angle to the horizon. This was the discovery of the phenomenon of rotor gliding.'

27. "The prototype as constructed weighed 445 pounds. However, the forward compartment for the pilot is not shown in the photograph. The craft was displayed at the International Aeronautical and Automobile Exposition in Moscow in 1912. At that time, he distributed a pamphlet, 'A Short Description of the Yuriev Helicopter'. For his helicopter design, Yuriev was awarded an Exposition gold medal.

28. "The machine was ground tested and in the course of tests the main rotor drive shaft failed. Lack of funds forced Yuriev to discontinue the program. The onset of the first World War and the Russian Revolution prevented further development but after the lapse of several years Yuriev resumed his position as a leader in helicopter development under Soviet rule. This work will be described later.

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29. "While residing in Russia, Igor Sikorsky produced two coaxial rotor helicopters. The first machine was built in 1908 [redacted] when Sikorsky was a student at Kiev Polytechnic Institute. This helicopter included two two-blade rotors and was powered by a 12 hp 3-cylinder Anzani engine. The upper rotor was 15 feet in diameter and the lower one was 16.5 feet. The rotors turned about 160 rpm. Tests showed that the engine lacked sufficient power to lift the machine. In 1910 a second helicopter was built. This version was powered by a 25 hp Anzani. Each rotor was 19 feet in diameter and

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had three blades. The empty weight was about 400 pounds. This craft could hover its own weight but could not carry the operator. Shortly thereafter Sikorsky turned to fixed-wing aircraft. He produced a series of successful airplanes in Russia.

30. "There were other early century helicopter projects and proposals in Russia. In the field of aeronautical engineering Dmitri Riabouchinsky was a leader. Contemporaries were Gassovskii and Antonov, who were more or less active with helicopter projects.

31. "The work of Riabouchinsky is noteworthy because it represents the earliest record of wind tunnel tests of a lifting screw under the influence of a horizontal wind. These tests were conducted at the Koutchino (Tushino) Aerodynamic Institute near Moscow. In one test, a 0.98 feet diameter rotor was subjected to a wind of 20 fps at right angles to the axis. The resulting thrust was two and a half times that of a screw without cross flow. His work was published in 1909 edition of the Bulletin of the Aerodynamic Institute. Subsequently Riabouchinsky emigrated to France and in recent years was involved in work on jet propulsion systems.

32. "In 1908 Gassovskii submitted a proposal for a helicopter to the Military Engineering Department of the Army. The design featured a device for variable pitch control. The proposal was reviewed by Col Naidenov and rejected.

33. "Konstantine A Antonov had been engaged in aerostat development until 1907 when he turned to the problem of the helicopter. In June 1909 he undertook a program to produce a coaxial rotor helicopter. The craft was built at the Lessner Works at St Petersburg and completed in January 1910 [redacted]. Later, Russian patent 21,172 was granted him on the device [redacted]. A tractor screw was included for propulsion. Two multiblade rotors were used. The blades consisted of triangular pieces of aluminum with one point at the hub. Each blade had pivot points at the hub and tip where it was attached to a large ring. This permitted the blades to change pitch. By lowering the pitch of the blades a disk was formed which was intended to safely lower the craft in case of power failure. The prototype was fitted with a 35 hp engine. The rotors were driven through a gear transmission system. Antonov conducted lifting tests with the machine but with poor results. Convinced of the futility of further research, the inventor destroyed the machine.

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HELICOPTER DEVELOPMENTS IN USSR

34. "The onset of the first World War and the subsequent Revolution in Russia obviated helicopter development during this period. The Soviet aircraft industry was always small in comparison with other nations. To the beginning of 1917, the year of the Revolution, Russia built about two thousand planes and less than six hundred engines. Almost three-fourths of the designs were of French origin. The only native designer of importance was Sikorsky.

35. "In 1918, the Air Force was taken over by the Soviet Republic. In December 1918 the main aeronautical laboratory was reestablished as the Central Aero Hydrodynamic Institute (ZAGI) in Moscow. Assisting in the organization was A N Tupolev who was to make a name for himself as the builder of giant airplanes. The laboratory is comparable to the NACA but ZAGI also undertakes the development of new aircraft or configurations including design and manufacturing of prototypes. When a ZAGI machine is accepted for production the fabrication in series is passed on to one of the many production plants scattered throughout the Soviet Union. Hence all ZAGI designated aircraft are experimental. This includes practically all the early helicopters built in the USSR. The various aviation institutes, which are engineering schools, have also produced aircraft prototypes which originated as design problems for students.

36. "In 1925 helicopter research began in earnest at ZAGI. The director of this group was the pioneer B Yuriev. Until 1928 he presided over the group with the assistance of Prof A Cheremukhin and A Izakson. Izakson took over in 1937 when Yuriev was 'transferred elsewhere.' Those were the days of the great purges when more than one aeronautical engineer fell out of favor with the NKVD. This included Tupolev. Other helicopter engineers at ZAGI were:

K A Bunkin	I P Bratukhin	V P Lapisov	D T Masitski	M S Abolduev
D I Antonov	G I Solnsev	I J Nikitin	B J Scherebtsov	A A Dokutchaev

Concurrently another group was investigating the problems of the autogiro.

37. "Initial work at ZAGI consisted of rotor configuration studies and ground whirl tests. The initial test investigated the characteristics of a two-blade cantilever rotor twenty feet in diameter incorporating cyclic and collective pitch control. This type of control was not new for it dated back to before first World War. The test stand was driven by a 120 hp M-2 engine rated at 1250 rpm. The M-2 was the Soviet version of the nine cylinder Gnome rotary of French origin.

38. "That the Soviets were no farther ahead in solving helicopter problems than were other nations is evidenced by an essay on the state of the art in 1928 written by Izakson and Cheremukhin:

> ' . . . all the methods of helicopter rotor action listed, simple in principle, are difficult to carry out and require numerous experiments for ultimate realization. Similarly the construction of apparatus for automatic slanting, alteration of speed, transmission, etc. is so complicated that up to the present no reasonable solution of these problems has been found.'

39. "In 1930 the first ZAGI helicopter appeared. It was designated 1-EA /Experimental Apparatus/. This one place craft carried a single four-blade lifting rotor and two antitorque rotors, one forward and one aft on the fuselage [redacted] The rotor had cyclic and collective pitch control [redacted] The pilot's control was an overhanging stick connected directly to the swashplate. It was reported in 1931 this craft piloted by Professor Cheremukhin flew to an altitude of 328 feet and remained in the air for 12 minutes. In August 1932 the helicopter was reported flown to an altitude of two thousand feet. In descending the craft went out of control resulting in a crash. These early Russian flights were never homologated by the F A I. The best contemporary F A I records were 58 feet altitude and an endurance of 10 minutes. The characteristics of the 1-EA included the following:

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Rotor diameter: 36 feet Four Blades
Engine M-2 rotary 120 hp at 1200 rpm
Rotor speed: 153 rpm
Rotor reduction: 7.84 to 1
Tail rotor reduction: 1200/1350

This helicopter was under development during the period 1930 to 1934 under the supervision of Izakson.

40. "The ZAGI 3-EA was similar to the 1-EA. The following performance was claimed:

Maximum speed: 13 mph
Range: 2 miles
Maximum altitude flown: 400 feet
Endurance: 10-14 minutes.

41. "The 5-EA was a machine of I P Bratukhin under development during the period 1933-37. This craft had a single six blade lifting rotor. Three of the blades, 32.4 feet in diameter, were fully articulated. The other three were 25.6 feet in diameter and featured variable pitch control. The 5-EA configuration was similar to the other models, the two rotors on the fuselage being retained. The pitch change mechanism in the rotor head was developed by Yuriev. All these early machines displayed poor flying qualities.

42. "The 11-EA was a convertible type with a lifting rotor and tractor screws. A smaller test version of the craft was built in the late 30's. This was designated 11-EA-PV. The PV added to the model indicated 'propulsive variant'. A smaller powerplant was used. This machine dispensed with the wing and hence became a gyrodyne configuration [redacted]. The engineers associated with this project were D J Savejlov and V P Lapisov. The 11-EA-PV was the forerunner of the much publicized OMEGA helicopter [redacted] Design on the OMEGA was initiated in 1939 by I P Bratukhin. The machine was first flown in 1941 by K J Ponomarev. This appears to be the first successful Soviet helicopter. The craft was a lateral rotor helicopter with powerplants mounted outboard on outriggers. The engines were M-11 radials rated at 145 hp each. Design values for the helicopter were 112 mph maximum speed, and 1100 fpm maximum

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rate of climb. The OMEGA was first publically displayed at Tushino Airfield near Moscow on Aviation Day, 18 Aug 46. The craft was awarded the Stalin Prize and went into production at plant 82 at Tushino. The OMEGAwas followed by a larger and improved 25X1 version also designed by Bratukhin, [redacted]. This machine was designed to carry a crew of two and six passengers. Two 690 hp A-SCH-21 seven cylinder radial engines were used. This version had an auxiliary wing and hence assisted in unloading the rotor. The latest helicopter is the OMEGA-3, a 24 passenger machine. This helicopter is in the prototype stage.

43. "In addition to the ZAGI programs there are other designs and projects of interest. These include the early post Revolution work of Yuriev, the work of Kamov and Isacco.

44. "In 1924 Yuriev obtained Soviet patent No. 761 for a jet driven rotor helicopter. [redacted] is a reproduction of the patent illustrations. Several variations are shown. 25X1 The basic design is a pressure jet helicopter. Yuriev identified it as the Nernst turbine cycle. Pressure was obtained by an engine-driven compressor or a centrifugal compressor in the rotor head geared to the rotor. Fuel jets are located near the blade 25X1 tips. Yuriev visualized the use of porcelain parts in the region of the burners. In the same year Yuriev was granted Soviet patent 1526 for a multirotor helicopter [redacted] 25X1 Each rotor was driven by a separate powerplant mounted on the fuselage frame. The multiengine feature was for safety. Control was obtained by surfaces in the slip-stream. One of the novel features of the device was a multi-throttle control mounted on the pilot's stick. Motion of the stick regulated the speed of the screws.

45. "N I Kamov was another pioneer who remained active under the Soviet regime. He played an important part in autogiro development in the USSR. His early work on helicopters dates back to 1933 when he was engaged in a jet rotor project. In recent years Kamov produced the K-17 which is a one place coaxial rotor helicopter mounted on floats 25X1 [redacted] The powerplant was a modified Aubier-Dunne motorcycle engine of about 17 hp The engine was of French design. The Soviets named this small craft 'vertolet' which means 'vertical flyer'.

46. "Vittorio Isacco is one of the world's foremost helicopter pioneers. During the 20's and early 30's he constructed helicopters in France and the UK. His designs featured blade mounted powerplants driving propellers. Advantages claimed for this arrangement were the elimination of a transmission and the attainment of gyroscopic stability. In 1932 Isacco was called to the USSR to build a giant helicopter of his configuration. The machine was constructed in Moscow at the Civil Aviation Institute under the direction of Isacco with A Izakson representing Soviet interests. The six place craft was completed in 1935 after three years work. The Helicogyre No 4 as it was designated, had blade tip mounted engines and propellers and a tractor engine propeller unit mounted in the 25X1 nose of the fuselage [redacted] The tip powerplants were 120 hp De Havilland Gipsy 3 engines. Each unit weighed about 350 lbs. The nose engine was a 300 hp Wright radial. The rotor was 90 feet in diameter and the flying weight of the machine was 7000 pounds. These characteristics yield a disk loading of 1.1 psf and a power loading of 14.6 lbs per horsepower. The resulting figure of merit is .405 based or power to the rotor only. Isacco contracted to build the ship but the flight test program was to be strictly in the hands of the Soviets. In 1935 he was given what in the US would be known as 'the bum's rush' and he left the USSR. To this day the designer does not know the fate of his machine. By 1936 Isacco had built or assisted in building nine heli-copters. For many years his residence has been in Paris where his current achievement is the development of a rotorchute with telescoping rotor blades.

47. "The most recently publicized helicopter has been that of M L Mil [redacted] During 25X1 the 20's, Mikhail Mil was one of the engineers who participated in autogiro development at ZAGI. The Mil helicopter is intended for military use. The craft has a three blade fully articulated rotor incorporating friction dampers. The diameter is 44.5 feet. This helicopter was publically displayed in Moscow on Aviation Day, 1951.

48. "Soviet writers have often made strong claims about Russian rotorcraft. Some of their remarks are included here:

'The USSR Information Bulletin says: 'The first flying helicopters were devised in the Soviet Union by Yuriev and his students. Yuriev and Bratukhin have found the correct forms of the helicopter and have elaborated the theory of rotors, which hitherto have been faulty and, therefore, unable to hold the machine in the air.'

In an article in Ogonek, B N Yuriev made some sweeping accusations: 'In 1925 . . . Koschel . . . copied in the most unscrupulous manner the designs of a Russian helicopter developed 15 years before and stole all our calculations. Sometime earlier, in The Netherlands a similar lack of restraint distinguished one Baumhauer and a year later a Frenchman, by the name of Oehmichen. In later years, Sikorsky, Piasecki, Hiller, Bristol, Bell and others "appropriated" the former labors of Soviet designers. All that US technology can boast in the field of helicopter design is a long forgotten stage in our research.'

25X1 In an article on Soviet 'firsts' the Yuriev helicopter was also included [redacted] The latter was also for a Soviet periodical.

49. "There is no doubt the Soviets deserve recognition for their historical achievements but they were not alone. The ideas of Yuriev on a tail rotor configuration and a pressure jet helicopter are particularly noteworthy. None of their rotor theories have been used by other nations. Western nations as well as the USSR adopted and expanded the early work of Cierva.

AUTOGIROS

50. "Autogiro development began in the USSR in the mid-20's with the official interest of the Special Designs section of ZAGI. This was shortly after the first flights by Cierva. Engineers associated with autogiro development were the following:

N I Kamov	M L Mil	A P Proskuryakov
V A Kuznetsov	V G Petrunin	V M Kvashin
N K Skrzhinski	A N Mikhailov	B V Bogatyrev

Autorotation tests were carried out during 1925-26. It subsequently became dormant at ZAGI due to projects of higher priority. During 1929-30 a design group of the Central Council of Osoaviakhim produced the USSR's first autogiro. The Osoaviakhim is the All Union society for the promotion of aviation and chemical defense. This organization carries Soviet youth through model building and gliding to flying powered aircraft. Part of its activities is to encourage aircraft design and many sportplanes were developed under its sponsorship.

51. "The Osoaviakhim autogiro was designed by Kamov and Skrzhinski. The prototype was designated KASKR-1 and named 'Red Engineer'. The four bladed autogiro was built around an Avro fuselage with a 110 hp Rhone rotary engine. The craft resembled contemporary UK machines. The KASKR-1 accomplished several brief take-offs but it displayed marginal performance. It ultimately crashed. The machine was redesigned
25X1 as KASKR-2 with a larger engine, a Rhone Titan static radial of 230 hp [redacted]. During 1930 satisfactory flights were made and this machine became the first to demonstrate the autogiro to the USSR. The take-off distance was comparatively long, the maximum speed was 63 mph and the maximum altitude flown was 1500 feet. Flights in this machine were discontinued in 1931.

52. "Toward the end of 1930 ZAGI reactivated its autogiro program. About a year later
25X1 the 2-EA autogiro appeared [redacted] This two place craft resembled the Cierva C-19 III with a four blade rotor, fixed wing, and aerodynamic rotor starter. The rotor was started by deflecting the propeller slipstream against the tail. The 2-EA used a 230 hp Titan engine and had the following characteristics:

Rotor diameter: 39.5 feet
Gross weight: 2130 lbs
Useful load: 520 lbs
Endurance: 1 hour, 45 minutes

The rotor blades were conventional consisting of a steel spar, wood ribs and a fabric cover. The machine was flown during 1931 and 1932 making a total of 48 flights logging about 18 hours of flying time. Performance of this machine with a speed propeller was as follows:

Maximum speed: 100 mph Minimum speed without losing altitude 34.2 mph
Ceiling: 11,000 feet Time to climb 10,000 feet: 26 minutes
Take-off distance: 165-200 [illegible] Landing run approximately zero

With an altitude propeller the ceiling was 13,800 feet but the top speed was reduced to 90 mph. With this machine ZAGI established the flight polar for an autogiro. In early 1933 the 2-EA was added to the Maxim Gorky propaganda group which toured the country spreading the gospel.

53. "In early 1932 the Special Designs Section engineered the A-4 which was built by the experimental design plant of ZAGI. The autogiro was completed late that year [redacted] This two place machine was intended for liaison and reconnaissance duties in the Red Army. The A-4 was a four blade rotor autogiro with an auxiliary fixed wing. Lateral control was obtained by ailerons on the wing. A mechanical rotor starter was incorporated replacing the clumsy aerodynamic starter of the previous model. This machine was a copy of the contemporary European and US autogiros. The blades consisted of a chrome-moly spar tube, wood ribs and a leading edge covered with aluminum. The aft end was fabric covered. This was the first Soviet gyro to be put in production. The A-4 was built for the Red Army and served through 1934. Its characteristics:

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Rotor diameter: 42.6 feet
Solidity: .097
Wing Span: 22 feet
Wing area: 66.5 square feet
Weight empty: 2343 lbs
Gross weight: 3000 lbs
Blade weight: 92 lbs
Blade pitch setting: 2.5 degrees
Stops flap: 25 degrees; droop: 7 degrees; lag: 1 degree half amplitude
Blade airfoil Gottingen 429
Powerplant: 300 hp at 1800 rpm M-26 radial
Propeller thrust axis tilt: 4.5 degrees downward
Maximum speed at S L: 106 mph
Minimum speed: 25 mph
Climb to 3220 feet: 6 minutes
Rate of descent: 18 fps at 31 mph
Takeoff Run: 120 feet in 10 fps wind
Landing run: 35 feet
Takeoff speed: 40 mph at 110 rotor rpm
Time to turn 360 degrees: 15 seconds
Maximum L/D: 6 at 2.5 degrees angle of attack.

54. "The A-6 autogiro was designed for Army liaison work in 1932 by V A Kuznetsov. The prototype appeared in May 1933 [redacted] This two place machine featured a three blade folding rotor and folding wings. A mechanical starter and rotor brake were also provided. This machine was powered by a 110 hp M-11 radial engine. The rotor diameter was 36 feet and the solidity .085. The gross weight was 1790 lbs and it weighed 1230 lbs empty. Performace was low, the top speed was 84 mph and the minimum speed was 34 mph. The take-off run was 214 feet. Presumably jump take-off was not a feature of this machine.

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55. "The A-7 series autogiros were designed by N I Kamov. The A-7 /Figure 25/ was a two place machine with a three blade rotor and tricycle landing gear. The M-22 powerplant was a Soviet built Gnome-Rhone radial rated 480 hp at 2000 rpm. The normal gross weight was 4300-lbs and the useful load was 1340 lbs. The horizontal speed range was 25-137 mph. This craft was in Red Army service and was used in the Tien-Shan area for exploring and forest patrol. It was perhaps the first rotorcraft used in war. The A-7 was reported to have served in the private war in Mongolia between the USSR and Japan during 1938 and 1939. The A-7-3a was an improved version. The rear cockpit carried a machine gun mount. In 1941 at the start of World War II, the autogiro performed liaison duties for the Red Army.

56. "ZAGI began the development of the A-8 autogiro around 1934. This two place craft included a fixed wing and featured a tilting hub and mechanical starter. The powerplant was a 100 hp radial engine. The maximum speed of the A-8 was 94 mph.

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57. "The ZAGI [redacted] was a high powered machine designed by Skrzhinski and built in 1937. The gyro was a one place direct control type with a 670 hp Russian Wright Cyclone radial engine. The speed range was reported to be 25-192 mph. The take-off run was 82 feet and the landing run about 30 feet. The ceiling was 2300 feet. The A-12 appears to be a Soviet attempt to produce a fighter autogiro. The stubby fuselage is similar to those of the fighters used in the Spanish Revolution. These in turn were modelled from the US Gee Bee racers of the early 30's.

58. "The A-14 was a project of Kuznetsov utilizing the same rotor system as the A-8. The craft was test flown by Capt Kochitz in 1936. A special feature of this model was the high endurance of seven hours. This was obtained by the use of auxiliary fuel tanks.

59. "Emphasis on autogiro development was indicative of relatively poor results with the helicopter. This was typical of other countries interested in the problem. By 1938 the helicopter was becoming a practical machine. This could be attributed in no small way to the experience with the autogiro. By the beginning of World War II the autogiro lost out to the helicopter. With the current interest in rotor gliders and convertiplanes the autogiro may return in a slightly different form.

60. "A recent Soviet rotor glider competition was sponsored by DOSAV in 1949. DOSAV is a voluntary society for assistance to aviation. Two designs were chosen for development. One was the design of V I Biryulin, the other, called 'Smolensk' was designed by M A Kaupfer of Moscow [redacted]. This design had a three blade rotor about 19 feet in diameter. The one place craft is towed into the air by means of a jeep. The rotor is started by a cable and drum at the rotor hub. The cable is staked to the ground, towing the glider starts the rotor.

25X1

CONVERTIPLANES

61. "The story of convertible aircraft dates back to the conception of the successful airplane. It was natural for inventors to add rotors to the airplane to increase its versatility. USSR has claimed to be the creator of the first successful airplane antedating the Wright Brothers by many years. They base their claim on the work of Mozhaiskii in the latter part of the 19th Century. He had proposed a design [redacted] around 1877. The craft was to weigh 57 poods (2050 lbs) and to be powered with a 14.5 hp engine. In that year a reduced model was flown for short periods of time. This encouraged him to petition the government for a subsidy to build a full scale prototype. The proposal was rejected and no full scale tests were ever made.

25X1

62. "One of the earliest ideas for a convertiplane was proposed by Grokhovskii in 1891. The lifting screws were two eight-blade propellers. These turned in opposite directions. The wing consisted of two balancers which were flat plates attached to the airframe. Propulsion was to be by means of an electric motor. The proposal was submitted to a government official, one Kovanko, who summarily dismissed it.

63. "A more active convertiplane exponent was V P Konovalov, a foreman at the arsenal in Sestroretsk near St Petersburg (Leningrad). Konovalov had been familiar with the work of Maxim and Langley. In October 1895, he submitted drawings and calculations for his machine to the Minister of Communications, Prince Khilkov. This design [redacted] consisted of two propeller wheels in tandem rotating in a horizontal plane. The blades were made of steel and set at a slight pitch angle. Surrounding the rotors were inclined circumferential tents set at an angle with the horizontal. The fixed surface area of each tent was 1080 square feet. The lenticular fuselage consisted of steel tubes covered with wire net. In the central part of the fuselage was a lifting surface 324 square feet in area. Two four-stroke cycle gasoline engines were intended for power. Each engine was rated 18.5 hp at 240 rpm. They weighed 217 lbs each. Fuel and oil tanks were centrally located and of sufficient capacity for two hour's flight. The weight of the proposed machine was 1320 lbs. Longitudinal control was to be achieved by slightly changing the incidence of the tents. Konovalov estimated the cost of a prototype to be 24,000 rubles but he was without funds. As many a successor did, he wrote to the Minister but received no assistance.

25X1

64. "During the 1900's in the reign of the last Czar, Nicholas II, a helicopter-airplane project was undertaken by Tatarinov. The proposed craft was called 'Aeromobile'. It consisted of four lifting propellers and a fixed plane [redacted] The frame carrying the powerplant and operator was slung below the rotor system. The wing area was 344 square feet. It was to be made of aluminum and featured a variable incidence. The wing was provided with four recess holes for the lifting screws. The gasoline engine drove the screws through cardan jointed shafts. The weight of the craft was 1300 lbs. The Ministry of War alloted funds for the construction of a prototype. By August 1909 the craft was partly complete. It was powered by a 20 hp Kott water-cooled engine. The transmission included a flywheel with friction clutch and a gear drive. A centrifugal propeller was mounted in the nose. Development of the prototype was slow. The alloted time for construction was running out. The Ministry instructed Capt Antonov II to examine the machine and submit a report. Tatarinov pleaded for eight more months time but the Ministry had decided the machine was 'technically impractical.'

25X1

65. "Tatarinov decided to continue his work without official assistance and found several supporters. He transferred his laboratory, under to the property of engineer Korsun. Again lack of money prevented him from completing his machine. He was . . . 'hounded by the yellow press for failing to justify the hopes placed in him.' In one of his dark days, 4 Nov 10, Tatarinov went into action. He set fire to his laboratory and destroyed all of his apparatus.

66. "Another convertiplane pioneer was F S Staravoitov, a laborer in the blast furnace department of the Taganrog Metallurgical plant. He proposed a machine consisting of two lifting screws, a tractor propeller and wings [redacted] His petition 25X1 included the universal plea of the unrequited inventor. His plea for financial aid was denied.

67. "The earliest convertiplane design under the Soviet regime was a proposal by F V Drozyshev. The craft was disclosed in Soviet patent No. 1993 (Figure 20). The configuration featured a tiltable wing, engine and rotor system. For control, the rudders were mounted on the upper surface of the wing in the rotor slipstream and elevators were located on the wing aft end. Figure 4 of the patent shows the control system with the wings vertical.

68. "Another Soviet convertiplane pioneer was G G Kerandina. The craft is disclosed in Soviet patent No. 2955 applied for in 1924 [redacted] The design consisted of a 25X1 single lifting screw and a fixed wing. A tractor propeller could also be fitted. The screws were driven by a gear transmission system. The wing was formed of spanwise rotatable surfaces which could be turned 90 degrees to permit air to pass through it.

69. "During 1935, ZAGI had an active convertiplane project, the 11-EA [redacted] This machine used the same rotor system as the 5-EA and included a fixed wing with two 25X1 tractor propellers. The rotor had a maximum diameter of 50.5 feet. The inner blades had a diameter of 30.2 feet. The machine was designed to take a 600 hp Curtiss Conqueror engine. At an engine speed of 2450 rpm, the rotor turned 192 rpm. A reduced experimental version was built. This became the 11-EA-PV helicopter. The propulsive screws were retained but the wing was omitted.

70. "The more recent Omega II helicopter may be classed as a convertiplane by virtue of its fixed wing. That convertible aircraft projects are active in the USSR is evidenced by the report of the wide speed range reported on some Soviet aircraft."

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Next 1 Page(s) In Document Exempt

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